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NIGHT-VISION DEVICE
[Nachtsichtgerät]

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(57) The wearing comfort of a night-vision device, consisting of an image amplifier with at least one objective optic and at least one observation optic for viewing the amplified image with the eyes of the observer, is improved over that of known night-vision devices, and the narrowing of the observer's field of vision is comparatively slight. To accomplish this, each observation optic consists of a fiber optic (**1**) and a concave mirror (**3**), the light-entry surface of the fiber optic (**1**) being aimed at the image plane of the image amplifier, and the light-exit surfaces (**6**) of the fiber optic (**1**) are aimed at the concave mirror (**3**) in such a way that those light rays exiting the light-exit surface (**6**) are reflected by the concave mirror (**3**) at an angle (β) different from zero, the concave mirrors (**3**) being arranged in the field of vision of the observer (**2**).

/1*

Patent Claims

1. Night-vision device, consisting of an image amplifier with at least one objective optic and at least one observation optic for viewing the amplified image with the eyes of the observer, **characterized by the fact** that

a) each observation optic exhibits a fiber optic (**1**) and a mirror (**3**),

b) the light-entry surface of the fiber optic (**1**) is aimed at the image plane of the image amplifier, and the light-exit surface (**6**) of the fiber optic (**1**) is aimed at the mirror (**3**) in such a way that those light rays exiting the light-exit surface (**6**) are reflected by the mirror (**3**) at an angle (ß) different from zero, and

c) the mirror (**3**) is arranged in the observer's field of vision.

2. Night-vision device according to claim 1, characterized by the fact that the light-exit end of the fiber optic (**1**) is arranged on an eyeglass frame (**4**).

3. Night-vision device according to claim 1 or 2,

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*Numbers in the margin indicate the column in the foreign text.

characterized by the fact that the mirror (**3**) is held on an eyeglass frame (**4**).

4. Night-vision device according to one of the claims 1 through 3, characterized by the fact that the mirror is a concave mirror.

5. Night-vision device according to claim 4, characterized by the fact that the at least one focal point of those rays reflected by the mirror (**3**) lies in the eye (**8**) of the observer (**2**).

6. Night-vision device according to one of the claims 1 through 5, characterized by the fact that the mirror (**3**) is integrated into an eyeglass.

7. Night-vision device according to one of the claims 1 through 5, characterized by the fact that the reflective surface of the mirror (**3**) forms the boundary surface of composite lenses (**10, 11**).

8. Night-vision device according to one of the claims 1 through 7, characterized by the fact that the mirror (**3**) reflects selectively.

9. Night-vision device according to one of the claims 1 through 8, characterized by a relay optic at the light-exit surface (6) of the fiber optic (1).

Specification

The invention concerns a night-vision device, consisting of an image amplifier with at least one objective optic and at least one observation optic for viewing the amplified image with the eyes of the observer.

Known night-vision devices, used for example for military purposes, but also by persons with night blindness, must either be held firmly in front of the observer's eyes with the hands, or mounted on the observer's head with a corresponding supporting system in such a way that the observer looks continuously into one or both eyepieces. A rigid geometry between the eyes and the night-vision device is thereby necessary. Continuous wearing of such a relatively large and heavy night-vision device is extremely uncomfortable and also optically unsatisfactory, because the field of vision is restricted to the relatively narrow field of vision of the night-vision device. /2 Finally, wearing the night-vision device is frequently rejected above all by night-blind persons for aesthetic and psychological reasons due to its unsightly shape.

Starting from there as a point of departure, the invention addresses the problem of increasing wearer comfort in the case of a generic night-vision device.

This problem is solved per the invention by the fact that

a) each observation optic exhibits a fiber optic and a mirror,

b) the light-entry surface of the fiber optic is aimed at the image plane of the image amplifier, and the light-exit surface of the fiber optic is aimed at the mirror in such a way that those light rays exiting the light-exit surface are reflected by the mirror at an angle different from zero, and

c) the mirror is arranged in the observer's field of vision.

The invention is accordingly based upon the basic concept of reflecting the amplified image into the observer's eye via a fiber optic and a mirror.

A night-vision device per the invention has among others the following advantages:

- the observer no longer needs to look into the eyepieces of the image amplifier, but only into a relatively small

mirror, one eye looking into one mirror and the other eye into a corresponding second mirror;

- the relatively large and heavy night-vision device no longer needs to be carried as a whole in front of the observer's eyes, rather, the image amplifier can be mounted at a distance from the observer's eye;
- the observer's natural field of vision remains entirely usable, because the observer can also see past the mirror, and the mirror can moreover be made permeable to light rays falling on its back side;
- the fiber optic and the mirror are comparatively light and can be attached to an inconspicuous supporting frame;
- the observer's head no longer needs to be turned directly toward something to be observed; it is sufficient, rather, to turn the objective optic of the image amplifier in the corresponding direction.

Advantageous execution variants of the object of the invention, which achieve, in particular a high effectiveness of the night-vision device, a comparatively attractive appearance as well as especially good orientation possibilities for the observer and the compensation of special eye defects are presented in the further claims.

The size, shape, selected material and technical concept of the above-named components to be utilized according to the invention are not subject to any special conditions, so that

known selection criteria can be employed without restriction in the respective application field.

Additional details, characteristics and advantages of the invented object issue from the following description of the /3 attached drawing, in which a preferred execution variant of a night-vision device according to the invention is illustrated. The drawing shows a horizontal section through the head of an observer with that part of the night-vision device essential to the invention mounted on an eyeglass frame.

An essentially known image amplifier which is not specially illustrated in the drawing, for example, a electronic residual brightness amplifier with a single or two parallel objective lenses for stereoscopic viewing, is carried, like a camera, in the hand, on a carrier strap in front of the observer's chest or even on a head-mounted holder. A prism or mirror arrangement in the optical axis of the at least one objective lens permits the depth of the structure to be kept very small in the viewing direction, so that the image amplifier will lie flat against the observer's body and not project needlessly in the viewing direction. The amplified light can, for example, be reflected by a substance such as phosphorus P20, whose peak intensity lies at approximately 550 nm and amounts at the half width to approximately 110 (from 510 to 620 nm). A fiber optic, whose light-entry surface is aimed at the image plane of the image amplifier and which is correspondingly aligned and held on the

image amplifier, can be employed instead of an eyepiece for the observation of the circular, light-amplified image appearing for viewing on the image plane (screen) of the image amplifier. Necessary corrections for adapting the image amplifier to the eyes of the observer can be provided among other things in the image-amplifier itself. In the case of the binocular version of the night-vision device illustrated in the drawing, two fiber optics are provided for image transmission.

Each fiber optic consists of a flexible bundle of aligned glass fibers whose surfaces can be treated in the known manner, in order to achieve the most optimal possible total reflection of that light transmitted in the inner lines. The fiber bundle is protectively jacketed and has, for example, a diameter of 6 mm. The photoamplified image is transmitted rastered by means of the fiber optic.

In the execution example, two fiber optics **1** are shown, whose jacketed fiber bundles are led out along the observer's neck and down behind the ears. This also corresponds more or less to the pathway used for the signal lines of earphones. The observer **2** utilizes, as a carrier frame for the observation optic which consist of the fiber optics **1** and two concave mirrors **3**, an eyeglass frame **4**, along whose ear bows 5 the fiber optics **1** are carried forward. The light-exit surfaces **6** of the fiber optics **1** are equipped with an eyepiece serving as a relay optic, arranged approximately from 1 to 2 cm in advance of the front ends of the

ear bows **5**, on the inner side of the same at approximately the level of the outer eye socket, and aimed at the concave mirror **3**; the concave mirrors **3** are positioned in the center of the field of vision of the eyes **8** of the observer **2**.

The concave mirrors **3** are preferably ground into the surface of the eyeglasses **9** and exhibit a diameter of preferably from 0.2 to 0.5 cm. The opening angle α of the concave mirror **3** relative to the eyes **8** amounts preferably to from 50° to 55°. As a result, the diameter of the concave mirror in the execution variant is approximately 0.25 cm. The radius of curvature of the concave mirror **3** is preferably selected in such a way that the focal points of the reflected rays lie in the eyes **8** /4 of the observer; a preferred curvature radius of the concave mirrors 3 is from **4** to 5 cm, whereas the angles of incidence β_1 and β_2, at the concave mirrors **3**, of those light rays leaving the light-exit surfaces **6** of the fiber optics **1** is preferably between 15° and 30°.

The eyeglasses **9** preferably consist of composite lenses **10** and **11**, which have been cemented together, whose contact surfaces are formed as parabolic surfaces and very thinly silvered; they serve as the concave mirrors **3**. The optical axis of the concave mirror **3** halves the angle between the line of sight of the eyes **8** and the optical axis of the light-exit surfaces **6** of the fiber optics **1**.

The reflective layers of the concave mirrors **3** reflect that light exiting the fiber optics nearly totally, whereas that light striking the eyeglasses **9** from the forward line of sight is not reflected, but passes in nearly a straight line, with slight absorption, through the glasses and through the back side of the concave mirrors **3**. The two image impressions - the immediate image based upon the direct incidence of light into the eyes and greenish, residually amplified reflected image - are thus superimposed for the eye of the observer.

The eyeglasses **9** of the night-vision device can at the same time be ground in such a way that they correct the observer's fields of vision, and this can take place independently of whether the reflective surface of the concave mirror **3** is ground into the eyeglasses. Any corrections needed to adapt the eyes to the image amplifier can be made on the relay optics, at the light-exit surfaces **6** of the fiber optics **1**.

The eyeglasses **9** and the eyeglass frame **4** can also assume the functions of entirely normal eyeglasses, if the concave mirrors are swung into the observer's field of view as needed.

Suitable as reflective material for the concave mirrors is, among other things, mercury which - as in a thermometer - is filled into a cavity in the eyeglass, behind the ground plane for the concave mirror **3**. The substances selected are preferably those which effect a selective reflection, preferably of green

light, and/or only a slight absorptive effect relative to light striking the back of the concave mirror.

The night-vision device disturbs the observer to a comparatively lesser degree, because it no longer needs to be worn in front of the eyes like normal eyeglasses, and neither excessively reduces the field of vision nor is disturbing from an aesthetic point of view. To improve the observer's orientation possibility and to minimize parallactic errors, the image amplifier with the objective optic can be arranged on the observer's head.